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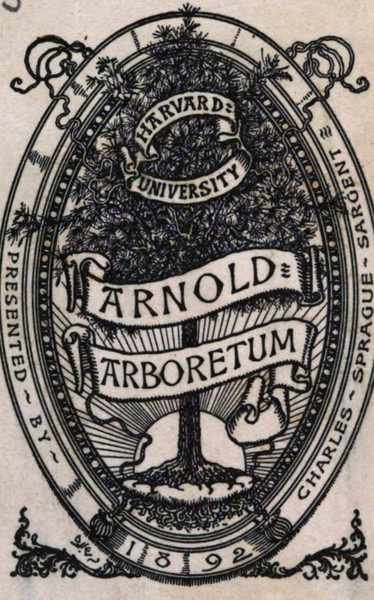

UNIVERSITY OF DURHAM PHILOSOPHICAL SOCIETY.

ON A CANKER OF THE OAK.

BY PROFESSOR M. C. POTTER, M.A., F.L.S.

(EXCERPT FROM THE PROCEEDINGS OF THE SOCIETY, VOL. II., PART 2.)

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ON A CANKER OF THE OAK.

(Quercus robur.)

By Professor M. C. POTTER, M.A., F.L.S..

[Read December 6th, 1901.]

[The Society is indebted to the English Arboricultural Society for the use of the blocks illustrating this paper.]

Perhaps the best known of the tree-cankers are those of the Larch, Ash and Apple, that of the first-named being especially destructive; but the disease is also of frequent occurrence on other trees.

Generally speaking, a canker arises from the local destruction of the cambium year by year through the action of a parasitic fungus, which is dormant during the summer and resumes an active condition in the winter. Where the cambium is destroyed, no formation of wood and bast can take place; and during the activity of the cambium, from early spring until late summer, an incomplete ring of wood is formed, partially growing over the injury with intent to heal it. Before the next season, however, the activity of the parasite is renewed, and the cambium around the cankered spot is once more destroyed, so that again only an incomplete ring of wood is formed. In this manner the activity of the fungus, alternating with that of the tree, defeats in each succeeding winter the attempts to repair the injury, and eventually a gaping wound is formed which never heals.

In the North of England, cankered Oaks are by no means uncommon. I have found them frequently on trees growing in shady and damp situations, such as the various Denes characteristic of this district, for instance: Deepdale, near Barnard Castle, Bothal, Plessey, Whittle-dene, and various woods on the banks of the Tyne.

A characteristic cankered Oak from Riding-Mill-on-Tyne is shown in Fig. 1. A great cavity can be observed on one side of the tree, and a conspicuous bulging out of the trunk on either side of it, due to the lateral extensions at the edges of the canker, caused by repeated attempts at occlusion. In the centre of the cavity a dead branch may be seen projecting from amidst the dead tissues. A transverse section taken in the plane of the saw-cut in Fig. 1 is shown in Fig. 2. The last complete ring of wood passes close to the base of the dead branch, where the canker-fungus entered. The tree would then be about twelve years old. It can be plainly seen that after this time no complete rings of wood were formed, and how the attempts to occlude the wound have caused the lateral expansions. The decay has gradually extended to the pith and along the edges of the wound. The sections taken above and below the canker showed the decay spreading in both directions along the centre of the tree. When cut down the tree appeared to be some thirty years old.

These cankers occur at various heights on the stem, from 4 to 20 feet or more. On examination of many specimens attacked in this way, I have almost invariably found numerous fructifications of a fungus belonging to the genus *Stereum* on and around the cankered spot.

No description of a canker caused by any species of *Stereum* having been recorded, the question arose whether this fungus was the cause of the canker or merely a saprophyte living upon the dead tissue. This I sought to determine by endeavouring to produce the disease by artificial inoculations from pure cultivations of the fungus, and after experiments extending over four years I have in this been entirely successful, and have definitely proved the parasitic action of the *Stereum*.

Fig. 3 represents a section through the fungus; the outer surface is composed of a series of club-shaped parallel cells (the *basidia*) forming the hymenium. Some of these project slightly and bear spores, generally four, at the extremity of spike-like projections; others, which do not bear spores, continue their growth and form the hymenium in the succeeding year.

The *Stereum* produces numerous spores during the winter months. Those employed in the experimental cultures were obtained on January 7th, 1899, from a cankered Oak growing in Gosforth Park, near Newcastle-upon-Tyne.

By placing a portion of the fungus face downwards in a sterile, covered glass-dish (petri capsule), I collected the spores as they ripened and fell off, free from the admixture of spores of other fungi. These spores were sown on January 8th, 1899, by means of a sterile camel-hair pencil, upon sterile blocks of Oak, in a number of large test-tubes plugged with cotton-wool. In a short time the spores had germinated, and the blocks of Oak became covered with a mycelium, eventually producing the *Stereum* form. The germination of the spores was also observed upon nutrient gelatin.

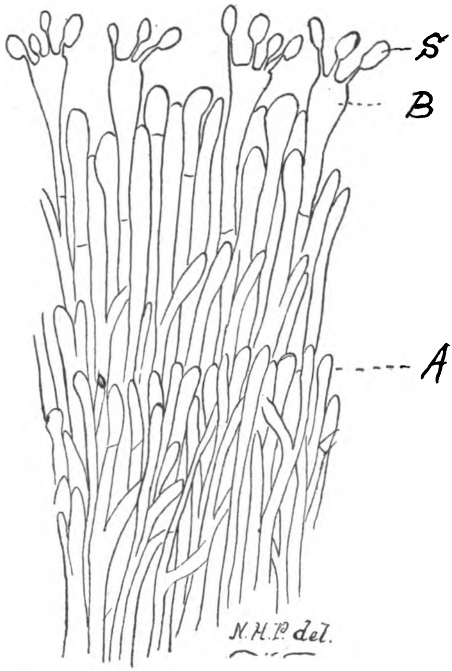

Fig. 3.—Portion of Hymenium of *Stereum*.
A—Hymenium of previous year. *B*—Basidium. *S*—Spore.

A number of seedling Oaks (3-4 years old), grown in the College garden, were first used for experiment, and numerous attempts were made to induce a canker upon them, but without result. Spores were sown upon the dead twigs, and pieces of Oak, permeated with *Stereum* from the pure cultures, were inserted like buds upon the stems. The conditions, however, were apparently unfavourable to the growth of the fungus. This was not surprising in the vicinity of a large town, where the atmosphere is charged with impurities, and the situation very dry and wind-swept. An attempt was therefore made to infect the young branches of Oaks growing under natural conditions in a wood, and this time with complete success. The trees selected were growing near the bank of a small stream. In many of the young branches, tangential cuts were made of about an inch in length, sufficiently deep to expose the wood, and a small splinter of Oak permeated with a pure culture of the *Stereum* was then inserted in the cut and firmly bound in. Exposure in this way naturally submitted the cultures to the risk of contamination, but under the circumstances this could hardly be avoided.

These out-door cultures were made in November, 1899, this season of the year being favourable for the growth of the fungus. Some of the inoculated branches were cut off at intervals, and brought to the laboratory for microscopic examination, and a series of observations were made at different stages of development.

The first examination, made in May, 1900, after a period of six months, showed that numerous hyphæ of the *Stereum* had grown from the inserted piece of Oak into the living tissues of the branch. The hyphæ, rich in protoplasm, could be seen passing across the lumen of the wood-vessels, both in the neighbourhood of the cut and near the pith; hyphæ could also be observed in the cortical cells at the edges of the incision. The amount of discolouration of the woody tissues was small, and confined chiefly to the medullary rays. There was no indication at this time of any activity on the part of the cambium.

Succeeding periodic examinations enabled me to trace the further development as described below.

During the summer an incomplete ring of wood was formed, together with a callus projecting over the edges of the wound. Meanwhile the *Stereum* remained dormant. On the approach of winter the *Stereum* resumed its active condition, penetrated deeper into the living tissues, as indicated by the brown discolouration, and growing especially at the edges of the incision, extended into and killed some of the cells of the callus. In a section cut from a specimen on the 11th of February, 1901, the discoloration was very pronounced, and extended in a broad zone from the edges of the incision deep into the wood and along the cambium line, being also particularly noticeable along the medullary rays. The callus covering the edges of the incision, formed a prominent feature of the transverse section, and this, too, was locally discoloured. The cells of the callus next the wood were brown and dead, and were no longer in close contact with it. Hyphæ were especially

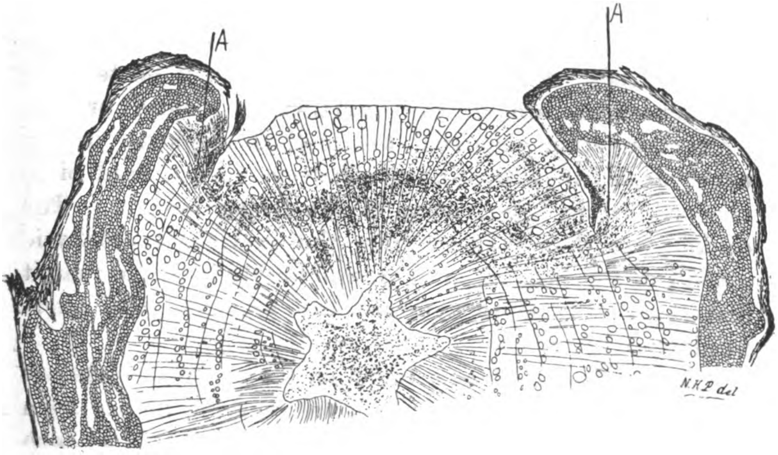

FIG. 4.—SECTION OF YOUNG CANKERED OAK.

The dotted shading indicates the region of discoloration due to the action of the *Stereum*. The parasite is seen to be penetrating the callus at *A*.

numerous in the wood-vessels, and were also found in the wood-vessels of the callus. Fig. 4 represents a section cut on September 17th, 1901. The dotted shading indicates the region of discolouration following the penetration of the *Stereum*.

The branches selected for inoculation were small, about half-an-inch in diameter, and showing some five to ten annual rings. On these, as we have seen, a miniature canker was produced from a pure culture of the *Stereum*. A continuation of the same process for a number of years would result in the large cankers described on older trees.

No fructifications of the *Stereum* have so far appeared on the artificially produced cankers; but these have only been observed when the canker has reached an advanced stage.

The study of naturally formed cankers indicate their commencement around the insertion of a dead branch. This observation suggested the method employed in my experiments, of cultivating the *Stereum* upon a dead piece of wood before introduction to the living branch. The canker was thus induced from the previous saprophytic growth of the fungus, and it seems highly probable that it first starts as a saprophyte on dead branches, and afterwards attacks the living tissue.

The patches of *Stereum* found on the cankered Oaks are small, irregularly shaped expansions, varying in size from $\frac{3}{16}$ of an inch in diameter, to $\frac{3}{4}$ of an inch long by $\frac{1}{2}$ an inch wide; they are resupinate, coriaceous, and inconspicuous, fitting in between the crevices of the bark to which they are closely applied, and concave, with slightly raised edge. The colour is pale gray to pale brown, corresponding to the *gris clair* and *brun clair* of Constantin and Dufour,* often with a lighter margin. The fructifications do not appear to increase in size after the first year. A number were selected on June 9th, 1898, and needle points driven into the bark at their edges; these were kept under close observation, and after eighteen months showed no enlargement. As the bark decays the fructifications die, and they are only found to be living round the edges of the canker. Their life appears to be limited to two, or at most three, years, and usually only two hymenial layers can be distinguished in the older specimens.

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* "Nouvelle Flore des Champignons," par M. J. Costantin et M. L. Dufour.

The spores are colourless, elliptical with rounded ends, 8·5 μ × 4·3 μ when measured in water directly they had become detached from the basidia. The basidia themselves are smooth.

In Massee's monograph of the Telephoreæ* there is no description of a *Stereum* which exactly fits the species here described. The species of *Stereum* cited as growing upon the Oak are *St. frustulosum*, *St. disciforme*, *St. spadiceum* and *St. hirsutum.* The three latter belong to a different section of the genus.

In *St. disciforme* the spores, 16 μ in diameter, or 18 μ × 14 μ, are very much larger than those of the canker-*Stereum,* and in other respects it differs greatly.

St. spadiceum has spores 8 μ × 5 μ the same measurements as those of the canker-*Stereum,* but the character of turning red when bruised found in *St. spadiceum,* together with the reflexed edge, quite distinguish this as a separate species.

St. hirsutum is very common upon felled Oak timber, in which it destroys the sap-wood especially, penetrating the duramen more slowly, and produces a whitish colour in the wood. It in no way resembles the form described here, the ochraceous colour of the hymenium and the form of the fructification at once distinguishing the two species.

St. frustulosum Fr. very closely resembles the canker-*Stereum,* but the spores are much smaller, being 4 – 5 μ × 3 – 3·5 μ, with subacute ends. This difference in shape and size of the spores, the cinnamon colour of the hymenium, together with the hair-like projections found on the basidia of *frustulosum,* appear to separate the two species. A more important difference, however, is found in the action of the fungus on the wood. Hartig has described *St. frustulosum* as causing the appearance technically known as "partridge wood." It attacks the heartwood, causing it to assume a brown colour with white spots somewhat resembling the feather of a partridge; the white spots eventually become cavities, so that the wood presents a honey-combed appearance. This parasite, as far as observed, enters the host from the roots, but the possibility of its effecting an entrance through a dead branch is not denied.

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* "Proceedings Linnean Society," vol. xxvii. 1890.

The action of the canker-*Stereum* upon the Oak is specially noticeable in the brown discolouration of the medullary rays, both in the artificial cultures and in sections taken from the stem, as in Fig. 2; but the appearance of "partridge wood" is never produced in the cankered Oak. The manner in which the timber is attacked differs markedly from *St. frustulosum,* the smoothness of the basidia also forms a very distinctive feature, and these, taken in conjunction with the characters enumerated above, incline me to consider the canker-*Stereum* a new species, for which I would suggest the name *St. quercinum.*

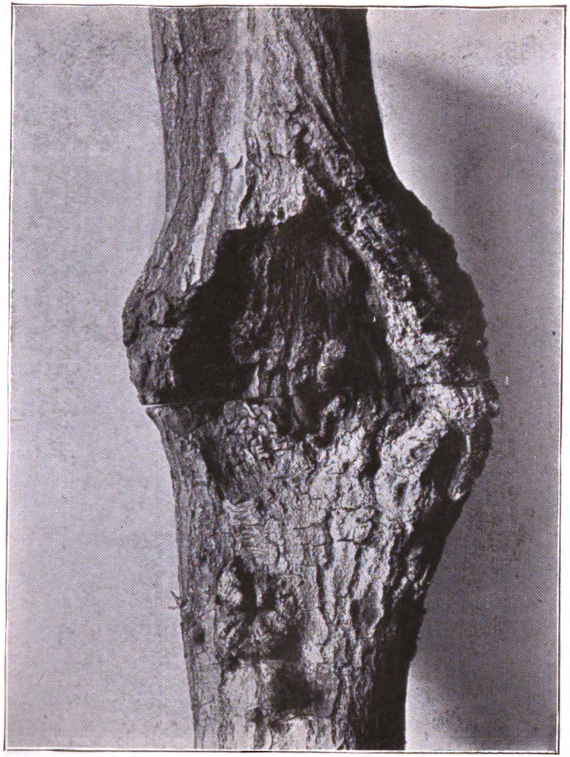

Fig. 1.

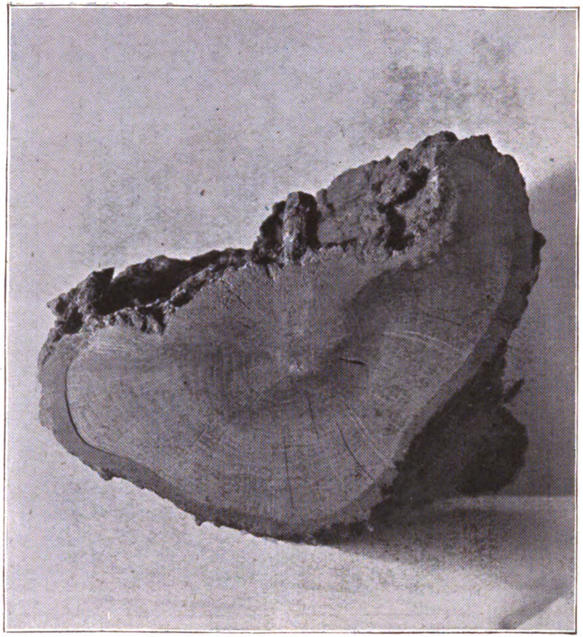

Fig. 2.

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